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Seeing the Invisible: Reflective Inquiry into Universal Design for Learning and Learner Diversity

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Abstract: In Japan's increasingly diverse higher education landscape, universal design for learning (UDL) has emerged as a promising framework for promoting inclusive learning environments. While existing applications of UDL tend to focus on structural strategies, this small-scale inquiry examines how an instructor's reflective practice plays a central role in realizing UDL's full potential. Grounded in Schön's model of reflective practice and informed by Brookfield's framework of critically reflective teaching, this research investigates how the instructor's perceptions of learner diversity evolved over a semester-long universal design course attended by 11 second-year students at a Japanese college. Data sources included students' learning logs and survey responses regarding barriers to learning and course evaluations. The analysis revealed various invisible barriers that students experienced, such as anxiety about communication, discomfort with group activities, and sensitivity to environmental factors. Concurrently, students showed diverse and less visible forms of engagement that occurred outside of classroom settings. Through critical self-examination, the instructor developed a deeper awareness of individual learning differences and began to challenge earlier assumptions that relied on observable behaviors as the primary indicator of student engagement. This metacognitive shift prompted changes in instructional decisions and teaching philosophy, illustrating how engagement with the UDL framework can stimulate critical awareness and evolving instructional perspectives. The study suggests that reflective practice may play an important role in helping instructors to fully engage with UDL and respond effectively to learner diversity. It also contributes to faculty development discourse by highlighting the potential of UDL to foster instructor transformation through reflective engagement toward more inclusive teaching.

Keywords: universal design for learning, reflective practice, learner diversity, instructor perception, higher education

1. Introduction

The steady rise in annual enrollment in Japanese higher education reflects increasing learner diversity, primarily driven by higher university enrollment rates among 18-year-olds [1]. As higher education has become more accessible, the number of students with disabilities has also increased. In the 2023 academic year, the number of students with disabilities reached its highest recorded level. Among them, the largest proportion had mental disorders, followed by chronic illnesses and developmental disorders [2].

In Japanese higher education, the provision of reasonable accommodation (RA) is mandated by the Act for Eliminating Discrimination against Persons with Disabilities [3] to support students with special educational needs. RA encompasses modifications to timing, instruction, course materials, and other learning environments. Examples of RAs for students with developmental disorders include providing reminders, allowing students to leave the classroom, and extending exam time [4]. As of the 2024 academic year, all universities in Japan, both public and private, are legally required to provide RA; however, research indicates a significant gap between policy and practice [5].

Furthermore, students with invisible disabilities often refrain from disclosing their condition due to fear of stigma or discrimination [6]. In general, students with disabilities tend to avoid requesting RA because of concerns about faculty or peer bias and negative past experiences [7, 8]. As a result, they may not receive the necessary accommodations, leading to disparities in educational opportunities. These challenges highlight the limitations of an approach that addresses accommodations on a case-by-case basis [9]. To mitigate these problems, it is important to minimize the need for students with disabilities to request RAs while fostering an inclusive learning environment accessible to all students [10]. Universal design for learning (UDL) offers a promising theoretical framework for addressing this issue. There is a growing need to explore how inclusive design frameworks like UDL can be implemented in higher education settings to reduce reliance on case-by-case accommodations and proactively support all learners [8, 11].

This study responds to that need by examining the implementation of UDL principles in a UD course at a Japanese college. It focuses on how UDL impacts instructors' perceptions of learner diversity through systematic reflective practice, drawing on the theoretical perspectives of Schön [12] and Brookfield [13]. Specifically, it investigates the following research question: How

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does implementing the UDL framework influence an instructor's assumptions about student engagement and learning behaviors? Through this inquiry, the study contributes to inclusive pedagogy by illustrating how reflective engagement with UDL principles can shift instructional perspectives.

2. Theoretical Framework

The UDL theoretical framework extends Ronald Mace's concept of UD to educational contexts, integrating insights from neuroscience, cognitive psychology, and other disciplines [14]. UDL not only supports diverse learners but also reshapes how instructors perceive and design learning experiences. As faculty members play a crucial role in creating environments that facilitate inclusive learning, engaging with UDL principles can lead to shifts in instructional beliefs and teaching approaches [15]. UDL operates on the premise that each learner is different and aims to cultivate "expert learners" who are purposeful, motivated, knowledgeable, and strategic in their learning [11].

From a UDL perspective, barriers to learning are not inherent to individual students but constraints embedded within the curriculum, including learning objectives, instructional methods, teaching materials, and assessment tools. To eliminate or reduce the barriers posed by a uniform "one-size-fits-all" curriculum, UDL advocates the intentional integration of diverse options and alternative approaches aligned with its three core principles—representation, action and expression, and engagement—throughout the curriculum design process. Additionally, UDL bridges theory and practice by offering practical guidelines and checkpoints to facilitate the gradual integration of UDL principles into teachers' educational practices. Furthermore, the framework also emphasizes the use of information and communication technology (ICT) to enhance curriculum customization to individual learner characteristics and needs [11, 16].

Thus, by applying UDL, educators can establish explicit learning objectives for their courses and cultivate flexible teaching approaches, materials, and assessments tailored to learners' varied requirements and preferences. In doing so, UDL fosters inclusive classes that support all students, including those with disabilities [17].

3. Literature Review

Research on UDL practices in higher education has been conducted worldwide. Yuwono et al. [18] systematically reviewed recent studies on UDL implementation in higher education, summarizing the methods, tools, and materials used. Their findings reveal three common elements: (1) multiple formats of learning materials—such as graphics, videos, documents, and e-books—aligning with the representation principle; (2) flexible options for assignments—including oral or written and digital or print formats—reflecting the action and expression principle; and (3) active learning strategies, such as group discussions, and digital engagement tools such as MindTap and Moodle, corresponding to the engagement principle.

Recent reviews indicate that UDL has the potential to enhance student engagement and academic outcomes [19]. Supporting these findings, King-Sears et al. [20] conducted a meta-analysis of UDL-related studies and reported positive effect sizes in students' academic outcomes when UDL principles were applied. In addition, research on students' perceptions of UDL, particularly among those with disabilities [21], has indicated generally favorable responses to the flexibility and autonomy that UDL provides. Such evidence highlights the practical efficacy of UDL in addressing learner variability through structured instructional design.

Despite these promising outcomes for students, few studies have explored how UDL influences faculty members' pedagogical beliefs and practices. Smith [22] provides one of the few cases demonstrating UDL's potential through a faculty member's reflective practice in a graduate-level course. This gap is particularly notable given that faculty play a central role in ensuring classrooms meet diverse learners' needs, yet many lack formal training in disability support or inclusive education [23, 24].

Recent studies have suggested that implementing UDL may increase instructors' sensitivity to diverse learning needs, regardless of whether students have disabilities. For example, Lambert et al. [15] emphasize that UDL is not merely a set of teaching strategies but rather a design process that enables instructors to critically reassess their assumptions about student learning. A recent systematic review by Rusconi and Squillaci [25] identifies a notable gap in understanding the effects of UDL training on teachers' reflection and collaboration, suggesting important areas for future research. While these findings support UDL's transformative potential, its long-term impact on faculty members' reflective practices and pedagogical decision-making remains underexplored.

UDL is predicated on designing a curriculum that addresses diverse learning needs; therefore, its effective implementation necessarily requires instructors to develop a deep understanding of that diversity. Expressly, the capacity to design inclusive learning environments hinges on the instructors' ability to perceive and respond to students' varied needs, barriers, and preferences, many of which may not be immediately visible. Without such understanding, even structurally inclusive designs may fall short of their intended impact. As Pritchard [4] notes, a deeper understanding of individual learners allows instructors to create experiences that better support knowledge acquisition and skill development. Moreover, UDL implementation is not a one-time task: it requires ongoing reflection and adaptation based on students' evolving needs and responses. Accordingly, examining how instructors perceive and adapt to learner diversity over time is critical for not only ensuring alignment between UDL principles and student realities but also understanding how UDL fosters ongoing pedagogical transformation.

Building on these insights, this study foregrounds the instructor as both a subject and an agent of reflective transformation in the UDL implementation process. Drawing on Schön's model and Brookfield's frameworks, it conceptualizes reflection as central to understanding how UDL engagement can reshape pedagogical beliefs and responsiveness to learner diversity.

4. Methodology

4.1. Research design

This study employs Schön's [12] model of reflective practice as its primary methodological framework. Schön conceptualizes reflective practice as the practitioner's ability to reflect both during and after professional action—termed Reflection-in-Action and Reflection-on-Action, respectively. To deepen the analytic scope of this approach, Brookfield's [13] framework of critically reflective teaching is also employed, offering a multiperspective strategy for examining implicit assumptions within instructional decision-making. This approach encourages reflection through four distinct lenses: the instructor's own experiences, students' feedback and perspectives, colleagues' observations, and relevant theoretical literature. Together, these frameworks provide conceptual lenses for examining how reflective practice shapes the instructor's evolving perception of learner diversity within a UDL-based course.

4.2. The researcher's experiences and background

Reflective practice necessitates acknowledging how personal experiences shape academic perspectives. This section outlines my background and shows how it informed my approach to teaching and research.

During my early schooling, I suffered from undiagnosed difficulties in learning and communication, such as trouble concentrating on long texts and both cognitive and emotional exhaustion experienced during group interactions. These experiences have heightened my sensitivity to students facing similar, invisible barriers and continue to inform my efforts in supporting diverse learning needs as a faculty member. This commitment led me to explore more inclusive approaches to instructional design, ultimately guiding me to UDL. My interest in UDL was further reinforced by the growing emphasis on active learning in Japanese higher education, where structured group work is often presumed to be effective [26, 27]. For students like me, such assumptions can create unnecessary burdens. Consequently, I was determined to avoid reproducing these difficulties, seeking instead to design a learning environment that honors a range of student learning preferences.

By engaging with the UDL theory and refining my own practice, I came to question not only how students learn but also how my own instructional assumptions evolved over time. This reflective stance ultimately shaped the central research question of this study.

4.3. Course design

4.3.1. Course planning and assignment details

This study was conducted post-COVID-19 within the "Practice of UD" course, a regular elective I taught for second-year college students. The primary learning objective was to "acquire knowledge about UD for objects and information and apply this knowledge in proposing UD-based improvements." The course was delivered in a face-to-face format, aligning with the course implementation policy of my college.

The course covered the definition and seven principles of UD, case studies of UD in existing objects and facilities, UD fonts, and UD colors. Weekly assignments allowed students to utilize and apply the basic concepts learned in class. For example:

1) Week 1 assignment (AS1): Provided an overview of UDL and course guidance, requiring students to describe their learning plans for this course (what and how they wanted to learn).
2) Week 8 assignment (AS8): Served as a midterm summary of learning outcomes and reflection on UD principles, their applications, and implementation perspectives and processes.
3) Weeks 12–14 (AS12–AS16): The final assignment applied UD knowledge and skills to a real-world design challenge. Students followed a stepwise approach:

a. Identifying what should be improved (AS12).
b. Defining product users (AS12).
c. Analyzing what barriers exist for each user (AS12).
d. Selecting tools for UD-based redesign and proposing improvements to address user barriers.
e. Selecting formats for presenting the proposed improvement (AS13).
f. Presenting the proposed UD products to an audience of the students' choice using any method (AS14).
g. Reflecting on presentations (AS15).
h. Submitting final presentation materials in an electronic format (AS16).

Additionally, students reflected on and evaluated their course learning at both the midterm (Week 8; AS8) and end of the course (Week 15; AS17).

4.3.2. UDL applied course instruction

To develop a flexible and personalized curriculum that considered learner diversity, various instructional methods incorporating tools and materials were implemented, guided by the UDL checkpoints outlined in Appendix A. With the exception of assignments involving clickers (namely, the student response system that permitted the instructor to ask questions and immediately receive student responses) and written reflections, all assignments adopted a self-selection format that allowed students to choose from four learning resources—instructor, friends, web, and books—to align with students' diverse learning preferences (Appendix A; Instruction A). However, based on my teaching experience, students often struggle to strategically select learning resources at the outset; for instance, they may seek clarification from the instructor but hesitate to ask for help or lack clarity regarding effective learning strategies. To address these challenges, I encouraged students who appeared to be experiencing difficulties to identify specific areas of confusion and seek assistance as needed. Additionally, students who had successfully completed their work were asked to assist other students with their learning activities (B).

While assignments were generally due by 10:00 p.m. on class days, recognizing individual differences in learning pace among students, they were informed that late submissions would be accepted and extensions were available upon request (C). To further enhance learning engagement, lecture recordings and PowerPoint slides used in class were promptly uploaded to the learning management system (LMS) on the same day as each class, serving as both in-class aids and review materials (D). Additionally, a clicker feature was integrated into the LMS, enabling students to manage their learning progress in the final assignment and share this information with classmates (E).

Moreover, to promote autonomy and engagement, students were granted flexibility in several aspects of their coursework. They were allowed to freely select the content and subject matter of their assignments/projects (F), as well as the most appropriate materials or tools (e.g., Word, PowerPoint, Illustrator, handwritten poster, and video content) to present their results (G). They were also allowed to self-select the target audience (e.g., friends, instructors, and parents) and the presentation method (e.g., oral, video/audio content, and text chat) according to their preferences (G). To develop skills regarding self-assessment of learning objectives and outcomes, students engaged in free-text reflection at the end of each class (Weeks 8, 14, and 15; H).

4.3.3. Evaluation of course grades

Course grades were initially assessed on a 100-point scale. The grading was based on the submission status and content of the report assignments (AS8 and AS16) and regular assignments (e.g., AS1). Obtaining a score of 60 or higher was considered passing. In accordance with college regulations, scores of < 60, 60–69, 70–79, 80–89, and 90–100 were converted into 0, 1, 2, 3, and 4 grade points (GPs), respectively.

4.4. Participants

Twelve second-year college students enrolled in the course, 11 of whom (eight male and three female) participated in the study after providing informed consent. One student was unable to

provide informed consent due to frequent absences from the course and withdrawal mid-semester. Owing to ethical considerations, the number and content of requests for RAs have not been disclosed. All students majored in information science and multimedia and had previously completed courses on the fundamentals of information science, Microsoft Office software, and Adobe's graphic software during their first year.

4.5. Data collection

Data were collected from the 11 participating students enrolled in the course. Three primary data sources were used. First, student assignment submissions (e.g., Word or Excel files) and clicker responses were stored and managed through the LMS. The LMS also recorded additional data such as attendance, submission timestamps, classroom seating positions, and course grades. Second, data on students' perceived barriers to learning were collected in Week 1, when participants were asked to describe the obstacles they had faced in their prior educational experiences. Third, data were obtained from the end-of-semester survey, usually conducted by my institution, in which students evaluate their comprehension of and overall satisfaction with each course's content using a four-point Likert scale. The survey period spans two weeks, typically between Weeks 13 and 15 of each semester. Students assess each course separately; for this study, only data specific to this course were extracted and analyzed.

For data collection, a two-stage informed consent process was employed. Students received a clear explanation that participation was voluntary and choosing not to participate would not yield any disadvantages. Participants were informed they could withdraw at any time before the research presentation. To ensure confidentiality, all data were anonymized and assigned coded identifiers. This study was approved by the Research Ethics Committee of my affiliated institution.

Initial consent was explained orally in Week 1, while seeking permission to use student responses to the learning barriers questionnaire. Eight students agreed to the use of their responses for research purposes by submitting an online form. Follow-up consent was obtained in Week 15—the final week of the course—and included both oral confirmation and an online form. This consent included permission to use additional course data, such as LMS records and end-of-semester survey responses. Eleven students provided informed consent in Week 15.

During the course, I discussed classroom events with an academic affairs staff and informally retained these experiences in memory. After the course completion, I documented these recollections as brief memos, which supported my subsequent reflections and contributed to drafting this manuscript.

4.6. Data analysis

Data retrieved from the LMS were analyzed to obtain contextual insights into students' engagement patterns and classroom dynamics. Assignment submission rates were calculated using these data. To support the interpretation of students' learning experiences, triangulation was conducted using data from the institution's end-of-semester course survey, which provided external validation of students' perceived comprehension and satisfaction with the course. Selected open-ended responses—specifically, students' initial survey answers on learning barriers (Week 1) and their reflections submitted as part of AS15 and AS17—were analyzed using a conventional content analysis approach [28]. Given the limited prior research on barriers to learning and engagement in UDL-based classrooms in Japanese higher education, no predefined coding scheme was used. Instead, codes were inductively generated through iterative reading and constant comparison of students' textual responses. These codes were then grouped into broader categories that captured recurring patterns and meanings. This process aimed to reflect the diversity of learning experiences and challenges in the students' own words. All coding was conducted manually using Microsoft Excel. Data saturation was confirmed at the final response of the learning barriers survey in Week 1, the reflections on presentations (AS15), and the course reflections (AS17).

The student reflections were originally written in Japanese. For the purpose of analysis, I translated the data into English using AI tools (DeepL and ChatGPT). The translations were then reviewed and refined in collaboration with a professional proofreader to preserve the original meaning. The same process was followed in preparing the manuscript.

A schematic flowchart of the research process, including instructional actions, data collection, and data analysis, is included in Appendix B.

5. Findings

5.1. Summary of students' learning achievements

Table 1 presents an overview of each student's assignment submissions throughout the course. Initially, some students did not submit their assignments; however, as the course progressed, most showed improvement, with the rate of assignment submission exceeding 80%, except for one student (S4). While four students completed all assignments, S4 neither participated in class nor submitted assignments for the first five weeks of the course. Remarkably, from the sixth week onward, S4 became actively engaged in the course and fully participated in learning until the final session. As an instructor, I was particularly interested in understanding what contributed to S4's transformation. Given the rarity of such cases, the subsequent analysis and reflection focused on students like S4 and S1, who initially exhibited low participation but showed significant improvement over time.

5.2. Barriers to learning

For the survey to identify barriers to learning, eight students submitted responses, excluding students S1, S4, and S8 (see Appendix C). Of these, at least four students identified communication with others, group discussions, and collaborative work as barriers to learning. Additional barriers mentioned included exams and grades (S5), excessive homework (S6), and environmental noise (S10). By contrast, S1 and S4, who had a history of low attendance and assignment submission, faced notable challenges that needed to be addressed. Initially, I questioned whether they would remain enrolled in the course. The following student reflections illustrate the range of challenges they faced:

> *My barrier to learning pertains to group behavior. I struggle with effective communication, presenting in front of others, and cooperating with others in learning activities. (S2)*
>
> *I previously assumed proficiency in team-based learning activities. However, after entering college, I had difficulty in contexts where numerous individuals congregated for learning. (S3)*
>
> *Communication with others poses a significant challenge for me. Participating in group discussions with unfamiliar peers exacerbates my discomfort. (S7)*

Table 1
Individual students' learning assignment submission rates

Student's ID	AS 1	AS 2	AS 3	AS 4	AS 5	AS 6	AS 7	AS 8	AS 9	AS 10	AS 11	AS 12	AS 13	AS 14	AS 15	AS 16	AS 17	Total number of submissions	Achievement rate
S1			✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	14	82%
S2	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	16	94%
S3	✔	✔	✔	✔	✔		✔	✔		✔	✔		✔	✔	✔	✔	✔	14	82%
S4						✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	12	71%
S5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	17	100%
S6	✔	✔			✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	14	82%
S7	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	17	100%
S8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	17	100%
S9	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	17	100%
S10	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	16	94%
S11	✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	15	88%

Note: Gray blank spaces indicate non-submission of assignments, whereas a checkmark indicates submission.

I encounter substantial difficulties in communicating and establishing human relationships. (S11)

These responses resonated with challenges I had grappled with as a student, particularly regarding group communication. However, upon reading the student remarks after the first course session, my initial response was characterized more by cognitive dissonance than empathetic recognition. It became apparent that a greater number of students were experiencing such barriers than I had previously assumed. This observation prompted further examination of my assumptions: Why had I presumed that my own experiences were uncommon? One possibility is that I had been influenced by a form of cognitive bias, interpreting my experiences as unique simply because they were not overtly discussed or visible in my educational environment.

I had long regarded myself as well-informed about learner diversity due to my personal background. Yet, this assumption limited my perspective. Specifically, I had overestimated the distinctiveness of my insight and underestimated the prevalence of similar, though often invisible, challenges among students.

Through practice and reflection, I recognized the importance of critically reevaluating my perceptions. Acknowledging this deepened my understanding of learner diversity and further motivated me to engage in UDL practice. It also further strengthened my commitment to advocate for students who face learning challenges.

I believed that many of the barriers identified by students could be addressed through UDL-based course design (see Appendix A; Instruction A). This realization made me more intentional in explicitly reassuring students that they were free to choose the learning methods best suited to the learning objectives. I often told them, "You're free to learn in your own way—as long as it helps you reach the learning goals!"

5.3. Students' engagement in the final assignments

This section describes students' engagement in the final assignments (AS12–AS16; Weeks 12–14).

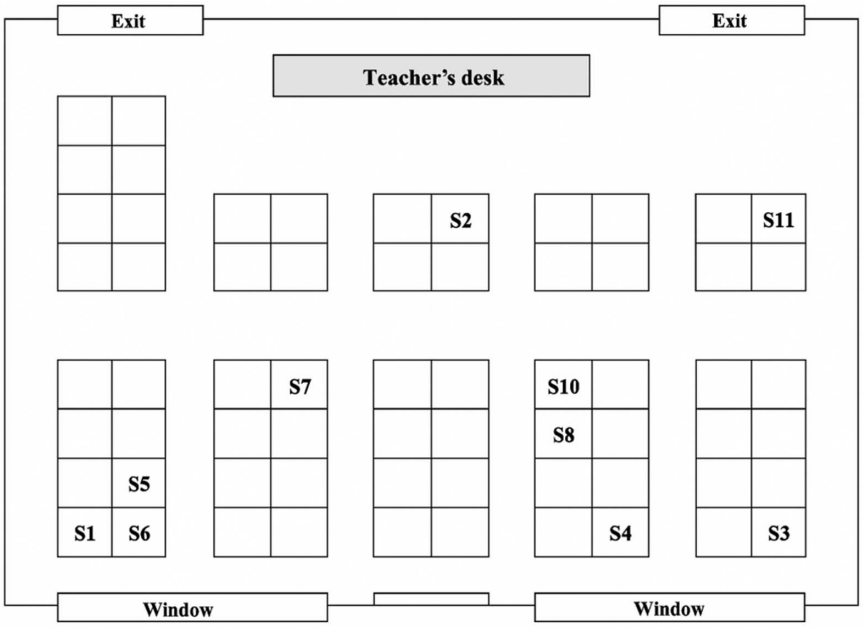
5.3.1. Selection of UD-based improvement objects

Students identified various objects for improvement based on UD principles. For instance, S1 redesigned bus timetables to enhance accessibility for individuals with low vision and older adults, simplifying route and schedule information. Similarly, other students' objects included pictograms for restrooms (S2), road lane markings (S3), and marker pens (S4). While some of the proposed improvements were more aligned with creating barrier-free solutions rather than strictly adhering to UD principles, I did not impose a rigid distinction. Instead, the evaluation focused on students' efforts to identify problems and propose solutions within the UD framework.

5.3.2. Classroom dynamics during course tasks

Figure 1 illustrates the classroom seating arrangement during Week 14, when students compiled their UD proposals and presented their project outcomes. Each student had access to a desktop personal computer (PC), with a monitor mirroring the instructor's PC screen placed in the center of their seats. The classroom layout was designed to allow students to work on course assignments and listen to instructor-delivered lectures. The seating arrangement reflected a transparent distribution, likely influenced by the relatively small class size compared to the classroom capacity. This trend was consistent from the beginning of the course. Some students sat close to my desk (S2 and S11), whereas others were seated in a radial pattern around the desk. I often observed that some

Figure 1
Student seating arrangement during Week 14



students positioned themselves at a distance, leading me to wonder if they felt intimidated or simply preferred a more independent learning space.

Notably, one student (S11) consistently occupied a seat near the exit door, possibly indicating a psychological need for easy access to leave the room, either for restroom breaks or other reasons. Given that COVID-19 was still a concern during the course, windows were kept open as an infection prevention strategy. Students seated near the windows may have chosen these spots either for infection control or to alleviate classroom stress by having access to fresh air. Despite the presence of two adjacent pairs of students, the classroom remained notably *silent*.

In Japanese classrooms, silence is a common behavioral norm. Classroom silence has been recognized as an educational challenge because it can hinder activities such as speaking and discussions in second language classes [29–31]. Classroom silence is considered an attractor state caused by a complex interplay of internal (e.g., cognitive processing, identity, and emotions) and external factors (e.g., classroom environment, institutional structures, and societal influences) [30]. Specific examples of these factors include personal preference for silence[29], Japan's cultural influence, where silence is valued as a sign of respect and consideration for others (influenced by Confucian values), and a significant fear of making mistakes in front of instructors or classmates[30].

In this course, given the small class size and that many of the students struggled with communication, it was unsurprising that the classroom often fell into silence. However, the level of visible engagement appeared lower than I anticipated. From my perspective, students did not appear particularly active—there was little questioning of the instructor or discussion among classmates. I began to question whether the quiet atmosphere reflected student disengagement or limitations in my instructional approach.

Noting the uncertainty regarding student engagement, I implemented more individualized interactions, deliberately speaking to each student during classroom activities. Two students (S8 and S10) usually responded with a smile, while others (e.g., S1) replied with a few words in a soft voice. Student S4, in particular, barely spoke, only nodding faintly or murmuring inaudibly. S4 consistently made direct eye contact when I provided explanations, indicating a level of attentiveness that contrasted with their outward silence and limited verbal interaction. This subtle, nonverbal engagement challenged my initial assumptions about participation.

Nevertheless, at that time, I did not fully recognize that student engagement might extend beyond visible classroom behaviors.

5.3.3. Presentation of improvement plans and reflections

For the presentation of their outcomes, most students chose PowerPoint slides, with one student (S11) opting for a Word document. Clicker responses indicated that presentations were made to six friends, six family members, and two instructors (some students presented to more than one person). Among the students who presented to friends, two (S8 and S10) indicated they were classmates. Regarding the presentation method, 10 students delivered oral presentations. Of these, most used PCs for face-to-face presentations; however, S1 presented online via Discord, and S6 presented using an iPad connected to a television. S9 opted for a poster presentation, possibly due to discomfort with oral presentations.

Despite the silent atmosphere in the classroom, many students conducted presentations and discussions with others outside class time. It became evident that several students who appeared reticent in face-to-face classroom settings were engaging actively through alternative modalities, such as online discussions or post-class communications.

This finding suggested that observable classroom behavior only captured part of students' engagement, prompting me to reconsider my understanding of their behavior earlier based solely on in-class participation. One possible explanation for this behavior is that students who faced communication difficulties may have relied on their parents or friends rather than classmates they did not know well. However, this behavior should not be viewed negatively. Rather, it can be seen as an autonomous action, aligning with the UDL framework, which emphasizes students' active choices on how to engage in learning both inside and outside the classroom.

What may appear as reluctance to speak does not necessarily indicate a difficulty; it may instead reflect intentional adaptation to the environment, personal preferences, or cultural influences that shape how students engage. This led me to adopt a more nuanced understanding of student participation—one that respects diverse modes of expression, beyond what is immediately visible. The following statements from students' reflections on their presentations (AS15) illustrate their perspectives:

> *I believe I effectively conveyed my points to the audience. However, as my friend mentioned, I felt a lot of satisfaction after presenting the proposal. This experience made me appreciate the challenges of UD and those working in this field. (S1)*
>
> *I received feedback such as "I would like the proposal to be more in-depth," and "The slides were a little hard to read." However, the design concept of the proposed marker pen was praised. (S4)*
>
> *Due to insufficient practice, I struggled to maintain a good tempo during my presentation. This experience has taught me the importance of thorough preparation and practice, especially when using PowerPoint. (S10)*

These reflections underscore the benefits of course flexibility in deepening students' understanding of assignments, enhancing communication skills, and improving presentation techniques. Reading them alleviated my concerns about classroom silence. However, I also realized that classroom observations alone may not fully capture students' learning experiences, particularly those occurring outside the classroom.

A future practical challenge identified through my reflection on this course is supporting group cooperative learning in ways that align with students' preferences and comfort levels. Despite my intention to foster collaboration through instruction (see Appendix A; Instruction B), student reflections indicated limited engagement with classmates. While many students engage in collaboration outside of the classroom with trusted individuals, fostering opportunities for constructive peer interaction within the classroom could further enhance inclusiveness. To address this issue, integrating relevant technologies into the UDL framework may offer flexible pathways for students facing challenges in face-to-face communication. Examples include online discussion platforms [32] and virtual learning spaces [33]. Further practice and research on scaffolding students' social communication within the UDL framework are warranted.

5.3.4. Evaluation and reflection on course learning

The final assignment (AS17) provided a space for students to articulate their reflections and impressions of the UD course. For instance, student S1, who initially had difficulty attending class, offered a deep reflection on their struggles to understand others, stating:

> *As I could only think from my perspective, my ideas were imaginary. I repeatedly asked myself whether the ideas I proposed were correct. I designed them considering low-vision users; however, no individual around me had low vision, prompting doubts about the effectiveness of my solutions. (S1)*

Similarly, student S4, who had initially missed five consecutive weeks of the course, and another student expressed positive opinions about course flexibility:

> *The environment accommodated my preferred learning style. Learning in this course was comfortable, efficient, and suitable for me because I have always been uncomfortable with group activities, such as group discussions with numerous individuals or in pairs. (S4)*
>
> *I found this class to be considerate of diverse needs. The flexibility to select various tools for assignment submissions made the learning experience easy and enjoyable. I would recommend this course to future students as it prompted me to contemplate issues related to UD (for example, "What difficulties do people with disabilities face?" and "This tool was made for this kind of person."), which I had not previously considered. (S10)*

The UDL-based course design allowed students to choose their preferred learning methods, whether for individual or group learning, thereby making their unique needs more apparent (see Appendix A; Instruction A). While many students preferred individual learning in the classroom, they demonstrated higher motivation and engagement in discussions outside the classroom, particularly with parents or friends. These results align with previous studies demonstrating how the UDL framework enhances student motivation [34].

In addition, students exhibited unique backgrounds, awareness levels, and learning behaviors, reinforcing the idea that each learner's experience is inherently unique. Despite these individual differences, all students in the study completed the course. The GPs were as follows: two students achieved a score of 4, four each achieved scores of 3 and 2, and one obtained a score of 1, indicating that most students performed well overall. Moreover, the results of the end-of-semester course evaluation further supported these positive impressions and learning achievements. All seven students who responded reported feeling "satisfied" with their learning experience. In terms of understanding, five rated the course content as "well understood," while the remaining two selected "somewhat understood," indicating generally favorable perceptions of the course.

How might student behavior have differed in a less flexible and autonomous learning environment? Consider S1 and S4, who initially struggled with participation. If the learning methods had been limited to a prescribed approach (e.g., group learning only), their psychological burden may have increased, hindering their continued participation in the course. Consequently, even opportunities for learning outside the classroom might have been lost. This scenario suggests that for students facing similar challenges, including potentially myself, instructional flexibility plays a critical role in sustaining engagement.

6. Discussion

6.1. Pedagogical and practical implications

This study underscores the importance of reflective practice in implementing UDL-based instruction. One key insight is that instructors' assumptions—often shaped by their own educational experiences—can obscure their ability to recognize the full range of learner diversity, including cognitive or emotional barriers, individual preferences, and learning behaviors that occur outside the visible scope of classroom interaction. Critical self-reflection enables instructors to reconsider how they interpret student participation and engagement, especially when these are not readily observable during class sessions. By doing so, they may begin to uncover the often-invisible challenges that shape students' learning experiences, and reframe their pedagogical responses accordingly.

In practical terms, faculty members implementing UDL-based practices should monitor patterns of student participation using tools such as LMSs, online discussion boards, and student response systems. These tools can provide insights into learning behaviors that are not apparent during live classroom sessions. Educators should remain attentive to students' voices, regardless of disability status. They should also cultivate the awareness needed to recognize challenges and needs that students may not articulate directly [35].

Rather than viewing silence or non-participation as disengagement, instructors should consider such behaviors within the broader context of learner autonomy, communication style, and classroom culture. This shift in perspective may lead to more inclusive and empathetic course design. Instructors should move beyond the traditional role of information providers and act instead as facilitators of inclusive learning [36].

By continuously reflecting on these dimensions, instructors can foster environments that support multiple learning pathways and empower student agency. Reflective practice, therefore, serves not merely as a technique but also as a foundational stance that supports inclusive and adaptive teaching.

6.2. Theoretical implications

This study contributes to the theoretical development of UDL by demonstrating that its significance lies not only in instructional design but also in its potential to act as a catalyst for reflective practice. UDL offers concrete strategies for inclusive teaching; its transformative value emerges when educators critically examine their assumptions about learning, participation, and student diversity.

Recent scholarship has suggested that formalistic applications of UDL may reinforce normative expectations and obscure structural inequities [37, 38]. In these cases, UDL risks becoming a procedural checklist devoid of critical engagement with learners' lived experiences.

To address this concern, the present study demonstrates that reflectively engaged UDL practice can prompt deeper reflection on pedagogical assumptions. What began as an effort to apply UDL principles evolved into a broader reconsideration of how I interpreted student silence and invisible learning barriers, highlighting the limits of my initial understanding of learner diversity.

To conceptualize this process, the study integrated two complementary approaches: First, Schön's [12] reflective practice model, which emphasizes adaptive reflection in practice; and second, Brookfield's [13] framework for critically reflective teaching, which promotes ideological critique through multiple lenses. Together, these frameworks position UDL as a planning tool and a reflective stance that prompts educators to revisit the values and power structures embedded in their teaching.

From this perspective, UDL invites ongoing critical dialogue with one's pedagogical practice and institutional context, opening up possibilities for more responsive and equity-oriented approaches to inclusive education.

6.3. Institutional considerations

In the context of Japanese higher education, the UDL framework has yet to be widely implemented, both in classroom practice and in faculty development programs.

Limited adoption of UDL in Japanese higher education may stem from both cultural resistance and institutional constraints. Traditional lecture-based teaching and rigid assessment practices often clash with UDL's flexible, student-centered ethos, causing inclusive strategies to be seen as peripheral or impractical [39]. Simultaneously, time/workload constraints, a lack of opportunities to learn about UDL, and insufficient institutional support are major barriers to sustained UDL implementation [8, 40]. These entrenched cultural norms and structural challenges reveal that UDL adoption requires not only technical adjustments but also faculty development initiatives that are transformative, feasible, and context-sensitive, favoring personalization over rigid standardization.

To address this gap, a crucial first step would be to introduce the foundational concepts of UDL into faculty development initiatives [41]. However, such efforts should invite, rather than mandate, reflective engagement. Faculty development should treat reflection not as a procedural requirement, but as a voluntary and dialogic space that encourages self-directed inquiry and critical dialogue.

Interdisciplinary UDL workshops that facilitate narrative sharing and collaborative reflection may serve as effective entry points for instructors to critically reexamine their assumptions and teaching practices [42–44]. The phrase "for all students" may serve as a useful opening point for dialogue in such workshops. These shared spaces can create meaningful opportunities to revisit understandings of learner diversity and inclusive course design. Such efforts are essential for fostering a culture of inclusive pedagogy that is both sustainable and responsive to the increasing diversity of learners in Japanese higher education.

6.4. Limitations

This study has several limitations that should be acknowledged. First, the sample size was small (N = 11), and all participants were enrolled in a single college course situated within a specific institutional and cultural context in Japan. Notably, the course itself focused on UD, which provided a natural and conceptually aligned context for the implementation and discussion of UDL. This alignment supported the instructional goals of the course; nevertheless, it may have influenced students' responses and engagement in ways that were favorable to the UDL framework. As such, the results are not generalizable and should be interpreted as context-specific and exploratory.

Second, the study employed a reflective and qualitative design that relied primarily on the instructor's self-reflection and student feedback, without the inclusion of external observers, peer debriefing, or inter-rater coding. Data triangulation was used across LMS logs and two sets of survey responses to enhance trustworthiness; however, the absence of independent validation introduces a risk of interpretive subjectivity and confirmation bias.

Finally, all student responses were originally written in Japanese and analyzed in that language, before being translated into English for reporting. Every effort was made to preserve the original intent and tone throughout the multistage translation and editing process; nonetheless, subtle shifts in meaning may have occurred, and certain expressions may not have fully captured the nuance of the original language.

Despite these limitations, this study generated rich, context-specific insights into learners' experiences and the instructor's reflective understanding. These contributions enhance the study's practical relevance, particularly in similarly constrained or underexplored educational settings.

7. Conclusion

This study highlights that UDL's transformative potential does not reside solely in its design principles, but in how instructors critically engage with the diversity they encounter in practice.

Through reflective engagement, UDL can serve as a catalyst for rethinking normative assumptions and for recognizing forms of student variability that are often overlooked, such as unspoken difficulties, nontraditional participation, or less visible learning preferences.

Accordingly, faculty development initiatives should not only teach UDL as a technique but also foster the reflective dispositions needed to implement it meaningfully in diverse educational contexts.

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Ethical Statement

This study was approved by the Research Ethics Committee of the Fukuoka Institute of Technology (permission number: hm08-23) and conducted following the committee guidelines. The participants voluntarily provided the data after giving informed consent to participate in the study and to allow the results to be used in the research.

Conflicts of Interest

The author declares that he has no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Atsunori Fujii: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Funding acquisition.

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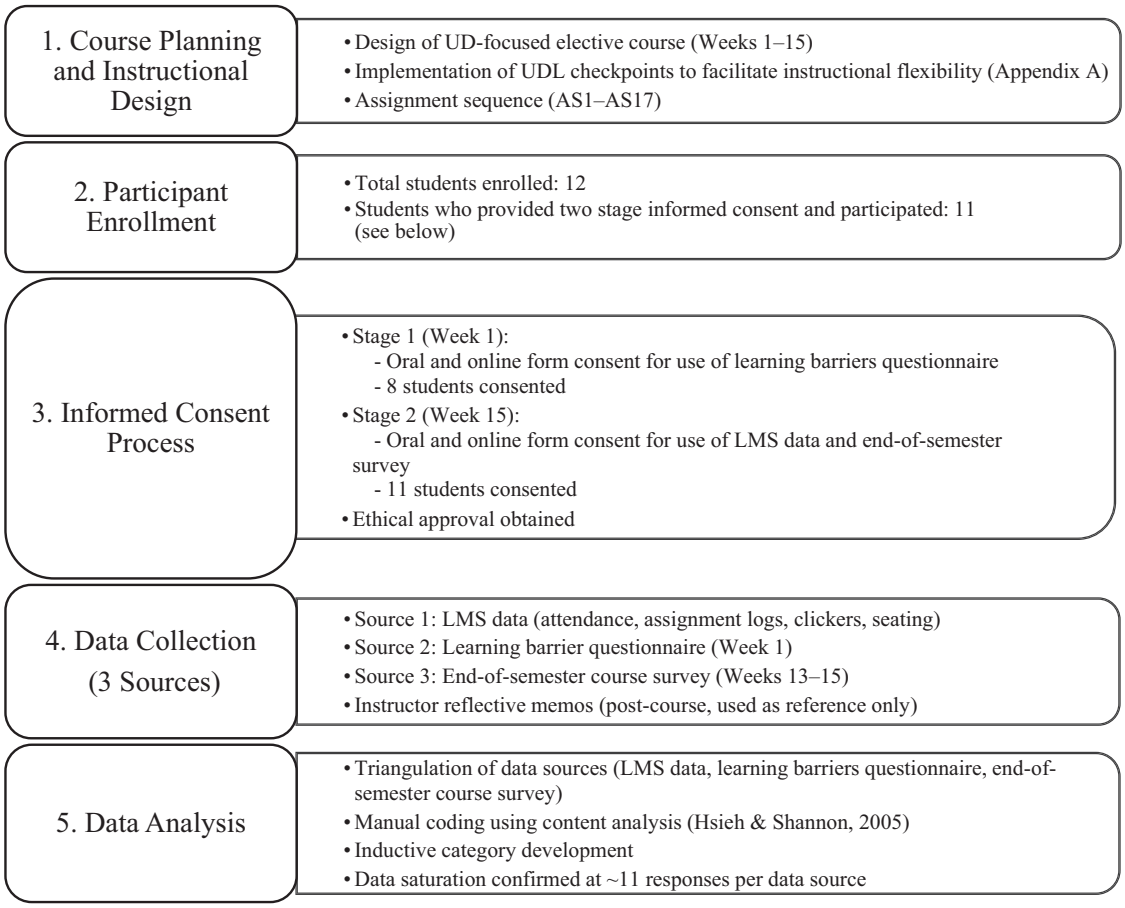
Appendix A: Instruction based on UDL checkpoints

Instruction	UDL Checkpoint No.	Week
A. Selecting learning resources (methods)	7.1, 8.3, 8.4, 9.2	1–13
B. Encouraging cooperative learning	8.3	1–13
C. Selecting the submission period of the learning/project assignment	6.1, 7.1, 9.1	1–15
D. Providing video content and PowerPoint slides for lectures	1.2	1–4, 7, 9–11
E. Providing clickers	6.4	12–14
F. Selecting the content of the learning/project assignment	7.1, 8.2	5, 6, 12
G. Selecting materials, tools, and methods for the presentation of their learning/project achievement	5.1, 5.2, 7.1	8, 13, 14
H. Reflecting on the course and own learning	9.1, 9.3	8, 14, 15

UDL Checkpoints

Principal I. (Representation)	Principal III. (Engagement)
1.2 Offer alternatives for auditory information	7.1 Optimize individual choice and autonomy 8.2 Vary demands and resources to optimize challenge 8.3 Foster collaboration and community 8.4 Increase mastery-oriented feedback 9.1 Promote expectations and beliefs that optimize motivation 9.2 Facilitate personal coping skills and strategies 9.3 Develop self-assessment and reflection
Principal II. (Action and Expression)	
5.1 Use multiple media for communication 5.2 Use multiple tools for construction and composition 6.1 Guide appropriate goal-setting 6.4 Enhance capacity for monitoring progress	

Appendix B: Visual flowchart of research procedures



Appendix C: Student responses on perceived barriers to learning

Student's ID	Response data	Code	Category
S1	[No response due to absence]	NA	NA
S2	My barrier to learning pertains to group behavior. I struggle with effective communication, presenting in front of others, and cooperating with others in learning activities.	Communication, Group collaboration	Social and communicative challenges
S3	I previously assumed proficiency in team-based learning activities. However, after entering college, I had difficulty in contexts where numerous individuals congregated for learning.	Collaborative work	Social and communicative challenges
S4	[No response due to absence]	NA	NA
S5	I was never particularly strong, academically. So, I often felt discouraged when I compared my grades with higher-achieving classmates. During class competitions where average scores were compared across classes, I sometimes felt guilty for dragging down my class's average due to my poor performance.	Exam and grades, Academic guilt	External performance pressure
S6	The volume of assignments during middle school vacation overwhelmed me, particularly while balancing extracurricular activities. I disliked being constantly checked on by senior students and classmates while completing assignments[1].	Excessive homework, Peer pressure	External performance pressure
S7	Communication with others poses a significant challenge for me. Participating in group discussions with unfamiliar peers exacerbates my discomfort.	Communication, Group discussion	Social and communicative challenges
S8	[No response due to lack of consent]	NA	NA
S9	In past physical education classes, which were mandatory, I found collaborative assessments particularly challenging. I was always required to pair up and take a test that would affect my grade. My limited athletic abilities often inconvenienced my partners, leading to feelings of alienation.	Exam and grades, Collaborative work	External performance pressure
S10	I have difficulty concentrating when people talk or there is noise around me.	Environmental noise	Sensory discomfort
S11	I encounter substantial difficulties in communicating and establishing human relationships.	Communication	Social and communicative challenges

[1] In some Japanese middle schools, especially in extracurricular club settings (e.g., sports teams), senior students or classmates may informally check on each other's summer homework progress. This practice reflects a cultural emphasis on group cohesion and mutual accountability, which may contrast with more individual-centered educational norms in other countries.